Collaboration with other projects

Publications and events

- Exhibition "Emotions: pain and pleasure in Dutch painting of the Golden Age" – Frans Hals Museum
- First Rijksmuseum Biennial Workshop on Future Directions in Computational Art History
- THz ARTE – International Workshop
- TECHNART 2015
- Digital Heritage 2015
- IEEE – NMD Conference
- Archeomatica (*www.archeomatica.it)*
- DigitalMeetsCulture (*www.digitalmeetsculture.net*)
- Digital Agenda for Europe (*http://bit.ly/1Ine24w*)
- DAE Blog (*http://bit.ly/1UQGuj1*)
- Euronews – Futuris (*http://bit.ly/1KhJvD6*)
- Press, radio, TV

Consortium

Coordinator

Technical Manager

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Integration of technological solutions for imaging, detection and digitisation of hidden elements in artworks

The research leading to these results has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement nº 600849.

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www.insidde-fp7.eu

September 2015

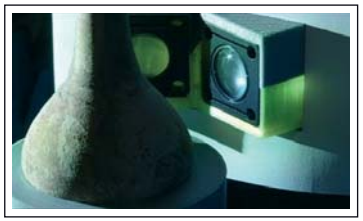
The project

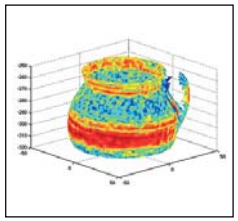
INSIDDE is aimed at **unveiling unknown features** – hidden paint layers, overpaintings, possibly underdrawing steps, brushstroke textures or sealed contents – o**f both 2D and 3D artworks** to enhance the knowledge-sharing of and the access to the digitised surrogates of the original cultural resources.

The combination of **terahertz (THz) technology, image processing techniques and 3D high-resolution scanning** is the basis for the generation of **complex digital models.** These will be **shared through Europeana** and have become key resources for the development of our **innovative Augmented Reality (AR) application for smartphones and tablets** to be used in museums.

Terahertz technology

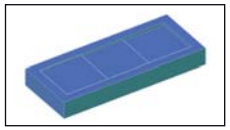
Being **non-ionising and non-harmful,** the capability of terahertz waves to **penetrate non-metallic materials** and **retrieving information from inner layers** makes them **suitable in the field of cultural heritage.**



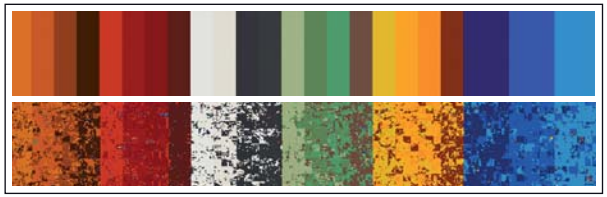


A THz scanner for artwork analysis has been developed, integrating novel graphene-based transmitters and receivers in the frequency bands between **140 and 330 GHz.** The THz radiation is focused on the surface under analysis through an **optical system, enabling the high-resolution automated scanning of real paintings and pottery** from museums.

Image processing techniques



Pigments and thicknesses can be identified and determined using image processing and supervised machine learning techniques on THz images and THz response patterns respectively. To this end, 5 mm by 5 mm islands with three different depths (100 μm, 200 μm and 300 μm) were designed, 3D-printed and filled in with diverse painting materials. **Obtained results were used to train automatic thickness classifiers** and to identify pigments.



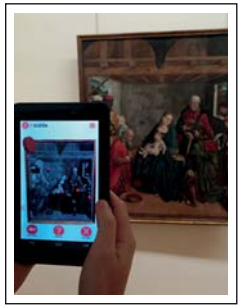
In addition, **supervised machine learning models are applied to classify different types of painting styles** based on high level brushstroke characteristics. For example, we used a collection of Van Gogh paintings (digital reproductions) from the Dutch and French periods, **resulting in 76% of the paintings correctly classified** in an automatic manner.

3D high-resolution scanning

High-resolution models of the exterior of ceramics from the 2nd and 3rd centuries have been created using a structured light scanner. These 3D models were further employed to provide the basis into which all the THz responses are integrated and to guide the THz scanner with the aim of getting **information about the interior of the ceramics.** Besides, the baked-in illumination from all 3D scans was removed to obtain the material's surface albedo, achieving a realistic appearance of the object. The resulting augmented models – interior and exterior – allow for easy dissemination within custom applications.

The structured light scanner is also used to create **3D relief of the paintings** to complement the 2D processing techniques.

Innovative applications and Europeana



Previously described research efforts are culminated with the development of an **AR-based application for smartphones/ tablets.** This will satisfy visitors' curiosity at museums by **interactively showing the scene** – THz, infrared, ultraviolet or X-ray images – **beneath the painting** and displaying information about other relevant (and not commonly known) characteristics and details. Besides, the **3D models and THz images** will be **uploaded to Europeana** to be shared with the citizens through the Internet, granting free access to the results.